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(54) Method and apparatus for noise measurement.

(57) Different methods of noise measurement are known. The activity of blocks of pixels can be measured and applied for noise measurement. However, it is difficult to distinguish between noise and picture content.
The invention uses the finding that the active picture content also contains signal parts of which the main activity is caused by noise. The probability distribution of measured block activity values of picture blocks is combined with a method of obtaining a running estimate of a particular point in the probability distribution and used for noise measurement. Thereby also the noise of signal parts with active picture content can be measured.

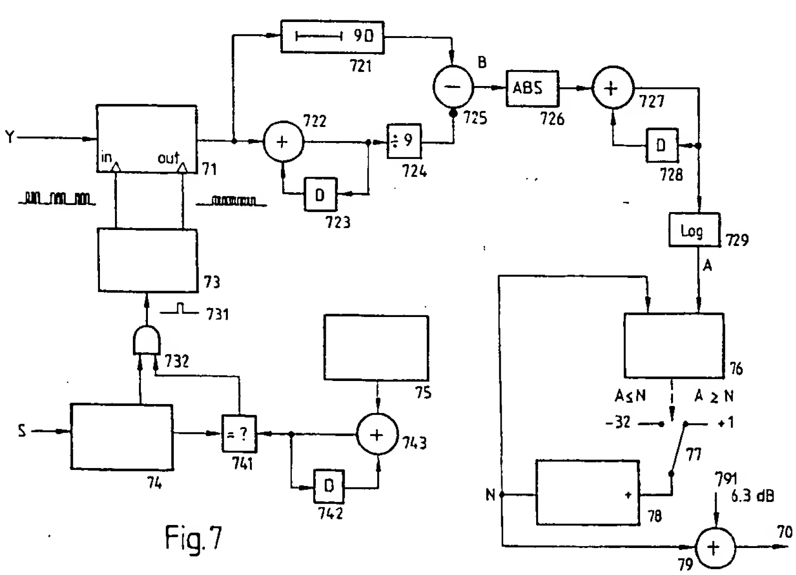

Fig.7

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The present invention relates to a method and to an apparatus for noise measurement.

Background

Different methods of noise measurement are known. The activity of blocks of pixels can be measured and applied for noise measurement. However, it is difficult to distinguish between noise and picture content.

Invention

It is one object of the invention to disclose an improved method of noise measurement based on the activity of blocks of pixel values. This object is reached by the inventive method disclosed in claim 1.

Advantageous additional embodiments of the inventive method are resulting from the respective dependent claims.

The invention uses the finding that the active picture content also contains signal parts of which the main activity is caused by noise. The probability distribution of measured block activity values of picture blocks is combined with a method of obtaining a running estimate of a particular point in the probability distribution and used for noise measurement. Thereby also the noise of signal parts with active picture content can be measured.

In principle the inventive method consists in a noise measurement, wherein the activity values A of blocks of pixels are calculated periodically and compared with an estimated noise value N stored in an accumulator circuit and wherein in case A > N a first correction value is added in said accumulator circuit to said noise value N and in case A ≦ N a second correction value, which is 10 to 100 times greater than said first correction value, is subtracted in said accumulator circuit from said noise value N.

It is a further object of the invention to disclose an apparatus which utilizes the inventive method. This object is reached by the inventive apparatus disclosed in claim 10.

In principle the inventive apparatus comprises means for capturing blocks of the active picture only at intervals determined by a pseudorandom number generator, means for calculating the mean value for each block and means for subtracting this mean value from the pixel values of the current block, means for calculating absolute values or squares of the difference values from the output of said subtracting means, means for summing up for each block said absolute values or said squares thereby providing said activity values A, a comparator for comparing said activity values A and estimated noise values N which have been calculated in an accumulator circuit, wherein controlled by the output logical value of said comparator in case A > N said first correction value is added in said accumulator circuit to said noise value N and in case A ≦ N said second correction value is subtracted in said accumulator circuit from said noise value N.

Drawings

Preferred embodiments of the invention are described with reference to the accompanying drawings, in which:

Fig. 1 shows the general function of the noise measurement;
Fig. 2 shows the measurement of activity;
Fig. 3 depicts a digital filter;
Fig. 4 shows the capturing of pixel blocks;
Fig. 5 shows in principle the block energy calculation;
Fig. 6 explains the process of statistical distribution;
Fig. 7 depicts an inventive noise measurement apparatus.

Preferred embodiments

In Fig. 1 the activity A of an incoming picture signal Y, e.g. a television signal, typically the luminance component, is measured periodically (e.g. 192 times per frame in case of 3*3 pixel blocks) in a measurement circuit 11 under the timing control of a sync signal S. The resulting activity values A are processed in a distribution circuit 12 according to their statistical distribution to produce a noise estimate N which varies either with the same speed or much more slowly than A, e.g. once per second.

Measurement circuit 11 is explained in more detail in Fig. 2. The picture signal Y passes a filter 21, typically a high pass filter whose output H approximates to the noise content of the picture signal more closely than the original picture signal does. Small blocks B of the filtered picture signal H are then captured by a block circuit 22 which is controlled by the sync signal S. The energy of each block B is calculated in an energy calculation circuit 23. The blocks may include any or all of the horizontal, vertical and temporal dimensions.

In one version of the invention, the picture signal is digital and is filtered by subtracting from it the mean of small blocks of the picture, as shown in Fig. 3. The mean of each block is calculated in a block mean calculator 32 and subtracted with a subtractor 33 form the picture signal Y which has been delayed appropriately by a delay 31. The blocks may be the same as those described below and may be captured in the same manner.

In another version, the filtered signal may consist

of the difference between the signal itself and an optimum linear or adaptive prediction of the signal.
In a further version, the video signal lines can be filtered with an one-dimensional analog high pass filter.

In one version of the invention, the blocks are captured in block circuit 22 by gating the clock Clk with AND gate 42 at the input to a serial shift register 41, as shown in Fig. 4. The second input of gate 42 is connected via control circuit 43 to the sync S. In this version, at most one block is captured every n lines, where n is the number of lines spanning the size of the block.
In another version, blocks are captured continuously by means of line delays.
In both versions, the block circuit 22 must ensure that only parts of the picture signal, which have been subjected to transmission noise and which have not been reconstructed in the receiver, are captured.

The energy of a block is calculated in energy calculation circuit 23 by summing the squares of the sample values in the block. Other approximations may also be used. A simple but effective approximation is to sum the absolute values rather than the squares, as shown in Fig. 5. The pixel values of block B are fed to an absolute value circuit 51. The output values are summed up in an adder 52. Each sum is intermediately stored in a register 53, e.g. a D-flip flop. This register is cleared with a block start signal 54 at the beginning of each block.
The resulting approximation to the energy of each filtered block constitutes an estimate of the activity of the corresponding portion of the original picture.
In one version of the invention, the final output A of this function is the logarithm of the estimated activity.

The samples of picture activity are processed, exploiting their statistical properties, in order to obtain a global estimate of noise on the picture which is as independent as possible of the detail in the picture. In one version of the invention, the noise estimate consists of a running approximation N to the k% point on the probability distribution of the activity samples, where k is typically between 1 and 10.
This does mean that within a given period k% of the activity samples A are below N and (100-k)% of the activity samples are greater than N.
Referring to Fig. 6, this approximation N is held in an accumulator N and is compared in a comparator 61 with the incoming A samples in turn. The output of comparator 61 controls a switch 62 which inputs either a first or a second correction value to accumulator 63. The following rule is applied:
If $A > N$: the first value is $+k*d/100$
Otherwise: the second value is $-(100-k)*d/100$

where d is a small convergence parameter (typically of the order of 0.01) that allows N to change slowly. The effect of applying this rule in a steady-state condition is to keep N at the k% point of the distribution of values of A.

If A (and therefore N) is expressed logarithmically, the final process is to add a correction value which depends on the block size and the activity measure A and which may additionally be allowed to depend on the type of transmission noise expected. Theoretical approximations to the optimum value of this correction may be calculated. Advantageously it is estimated by applying the noise measurement system to a typical picture with transmission noise whose power is also known by other noise measurement methods.

Advantageously the final noise estimate N may be calculated as a function of approximations not only to the k% point of the probability distribution but to other parameters that depend on this distribution, such as the median (the 50% point) or the mean.

A specific embodiment of the invention is shown in Fig. 7. 3*3 blocks of the active picture only are captured at intervals determined by a pseudorandom number generator 75. The output values of this generator are summed up in adder 743 and accumulated by a D-flip flop 742. A timing generator 74 receives a sync signal S and and provides active picture window information to an AND gate 732 and the sample count to a comparator 741 in which this sample count is compared with the output of adder 743. The output of comparator 741 is fed to the second input of gate 732 which outputs block start signals to a block clock generator 73. The block clock generator is connected to an input 'In' and to an input 'Out' of a shift register 71 which captures the 3*3 blocks as described for Fig. 4. From the output blocks of register 71 the mean value for each block is calculated using an adder 722 and a D-flip flop 723 for summing up the nine pixel values and a divider 724 which divides the sum by nine and outputs the block mean. This block mean is subtracted in a subtractor 725 from the pixel values of the current block which are appropriately delayed by delay 721. The high pass filtered block values B at the output of subtractor 725 pass an absolute value circuit 726 and are summed up for each block by adder 727 and D flip flop 728. The filtering operation consists of calculating the differences of block samples from the mean of each block and the energy is approximated by summing the absolute values of those differences.

The output of adder 727 passes a logarithmic value circuit 729 which gives values representing activity A. The statistical distribution processing consists of estimating the (approximately) 3% point

on the distribution of the logarithmic values of the activity.

A comparator 76 compares activity A und the noise estimate N which has been calculated in accumulator 78. A switch 77 is controlled by the output logical value of comparator 76 and feeds either (in case A > N) the number '+1' or (in case A ≤ N) the number '-32' to the input of accumulator 78. The number '-32' has been chosen because 32*3% ≈ 100%. The start value of accumulator 78 can be zero. Finally, a constant correction value 791 equivalent to 6.3 dB is added in an adder 79 to the noise estimate N, this having been calculated using artificial noise with a flat distribution added to a grey picture. At adder output 70 the final noise estimate N is available.

The noise values N can also be accumulated and allowed to change at the input of adder 79 with a smaller period, e.g. once per second.

Additionally, a further correction to the noise estimate N can be applied taking into account the mean activity of the picture, for example by subtracting 1/4*(B-15) from the noise estimate, where B is the mean activity of the processed blocks expressed in dB.

Claims

1. Method for noise measurement, wherein the activity values A of blocks of pixels are calculated (11) periodically and compared (61, 76) with an estimated noise value N stored in an accumulator circuit (63, 78) and wherein in case A > N a first correction value is added in said accumulator circuit to said noise value N and in case A ≤ N a second correction value, which is 10 to 100 times greater than said first correction value, is subtracted in said accumulator circuit from said noise value N.

2. Method according to claim 1, **characterized in** that the luminance values of said pixels are used for calculating said activity values A.

3. Method according to claim 1 or 2, **characterized in** that said blocks include any or all of the horizontal, vertical and temporal dimensions.

4. Method according to any of claims 1 to 3, **characterized in** that for calculating the activity value A for a block

   a) the mean of the pixel values of this block is subtracted (724) from each of these pixel values
   or
   the difference between this block and an linear or adaptive prediction of this block is calculated
   or
   video signal lines are filtered with an one-dimensional analog high pass filter
   wherein
   b) the absolute values (51, 726) or the squares of the resulting difference values or filtered values (B) of each block are summed up (52, 53; 727, 729).

5. Method according to any of claims 1 to 4, **characterized in** that said activity values A are calculated with a first period and said noise values N are accumulated and allowed to change at an output (79) with a second period which is less than said first period.

6. Method according to any of claims 1 to 5, **characterized in** that said blocks are taken only from the active picture lines.

7. Method according to any of claims 1 to 6, **characterized in** that said activity values A pass a logarithmic value circuit (729) before being compared (76) with said noise value N and that a fixed correction value (791) is added (79) to said noise value N.

8. Method according to any of claims 1 to 7, **characterized in** that said fixed correction value (791) is set to get a noise value N which has been received from a noise measurement of a typical picture with transmission noise using a different, known noise measurement method.

9. Method according to any of claims 1 to 8, **characterized in** that the multiplication factor for said second correction value depends on the median or the mean of the distribution of said activity values A.

10. Apparatus for a method according to any of claims 1 to 9, comprising means (71, 73, 732, 74, 741, 742, 743) for capturing blocks of the active picture only at intervals determined by a pseudorandom number generator (75), means (721, 722, 723, 724) for calculating the mean value for each block and means (725) for subtracting this mean value from the pixel values of the current block, means (726) for calculating absolute values or squares of the difference values from the output of said subtracting means (725), means (727, 728) for summing up for each block said absolute values or said squares thereby providing said activity values A, a comparator (76) for comparing said activity values A und estimated noise values N

which have been calculated in an accumulator circuit (78), wherein controlled by the output logical value of said comparator (76) in case $A > N$ said first correction value is added in said accumulator circuit (78) to said noise value N and in case $A \leq N$ said second correction value is subtracted in said accumulator circuit (78) from said noise value N.

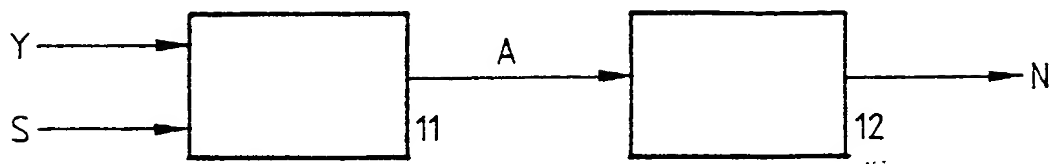


Fig.1

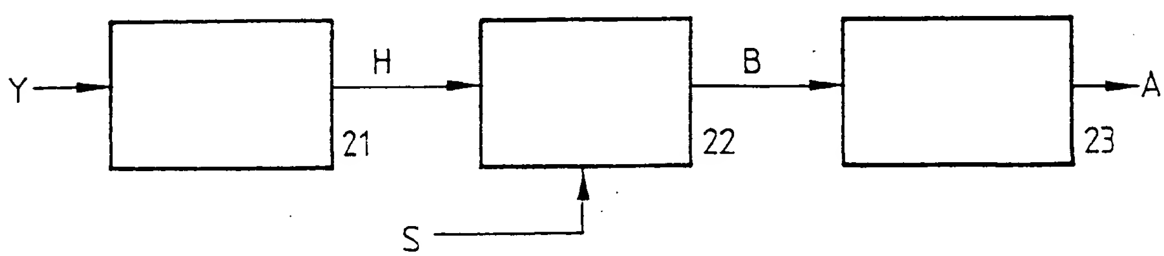


Fig.2

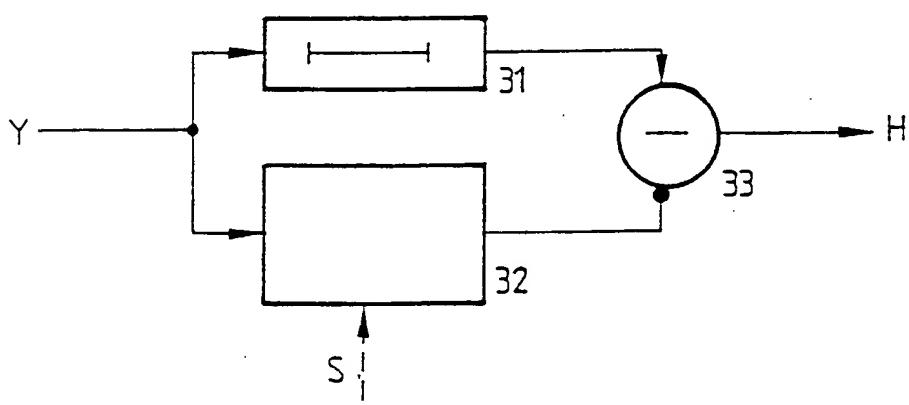


Fig.3

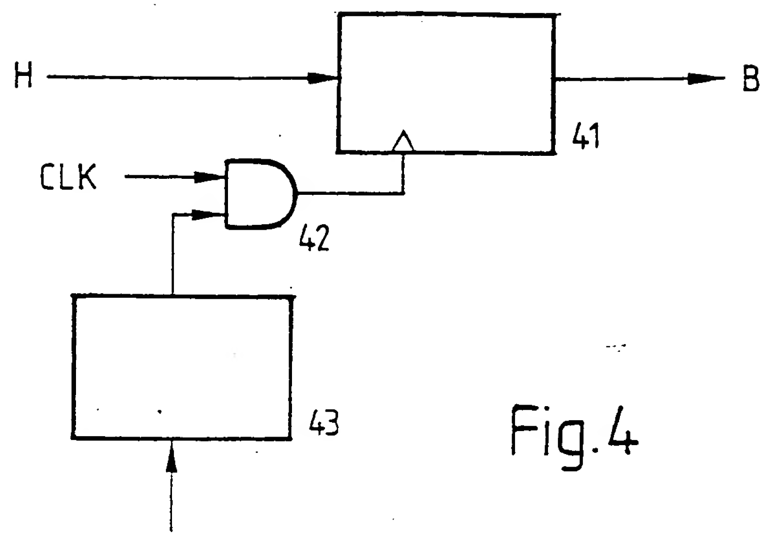


Fig.4

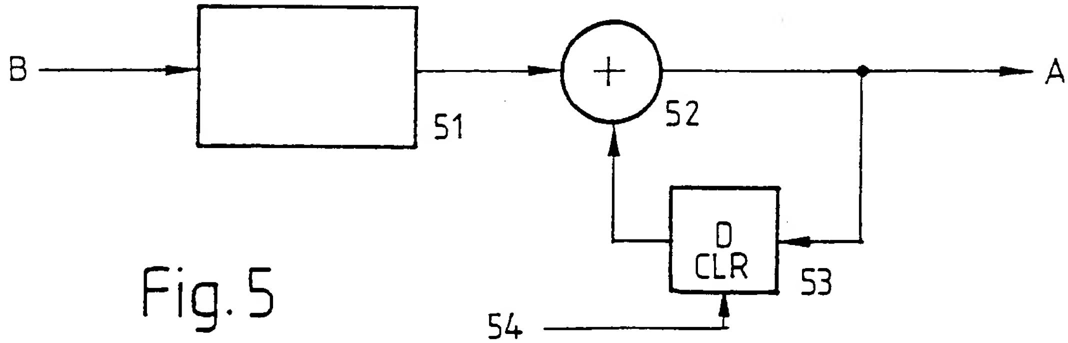


Fig. 5

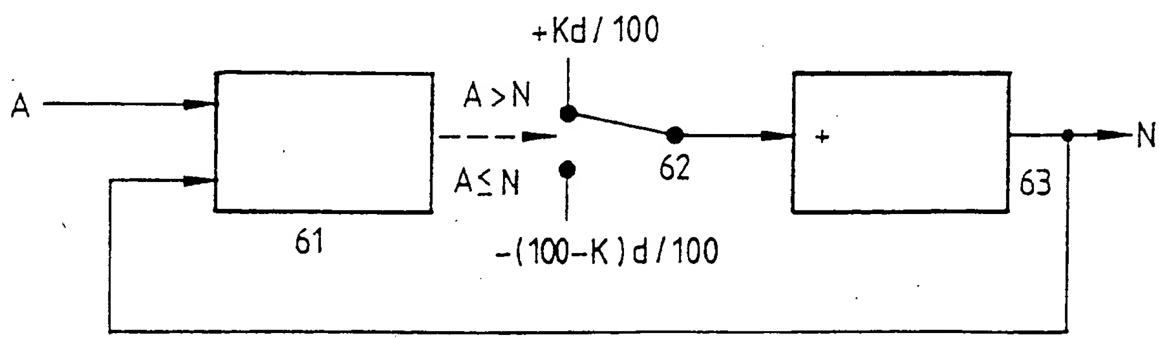
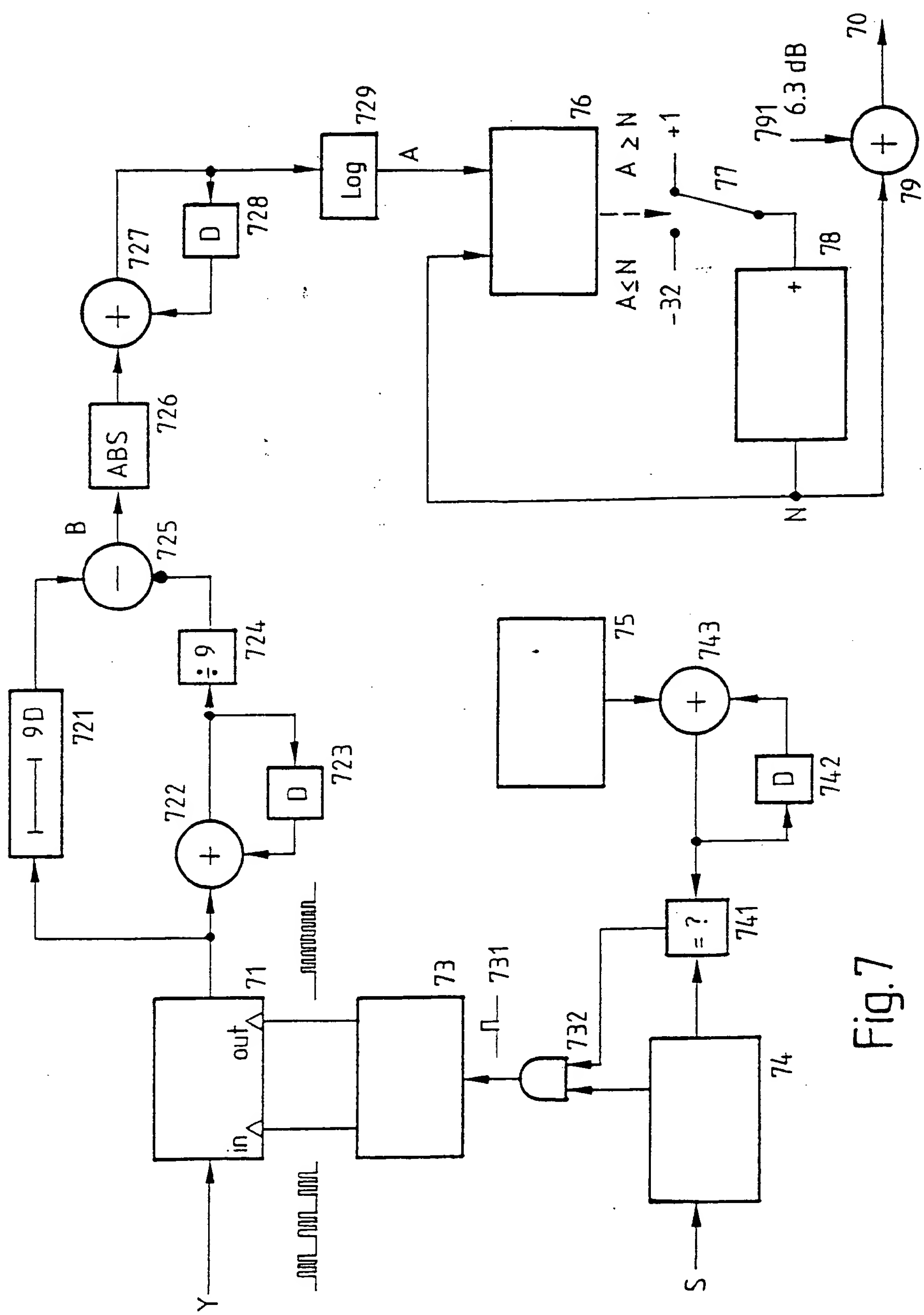


Fig.6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76
A ≥ N
A ≤ N
+1
−32
77
+
78
791
6.3 dB
79
70
N

Fig.7

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EUROPEAN SEARCH REPORT

Application Number

EP 93 10 4181

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-4 074 201 (LENNON) * column 2, line 4 - column 3, line 59; figure 1 * ---	1,9	H04N17/00 G01R29/26
A	EP-A-0 109 037 (CIT-ALCATEL) * page 11, line 20 - page 15, line 12; figures 1,2 * -----	1,9	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H04N G01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 JUNE 1993	YVONNET J.W.

CATEGORY OF CITED DOCUMENTS

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